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DATA TRANSMITTING DEVICE

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[There are no amendments to this patent.]

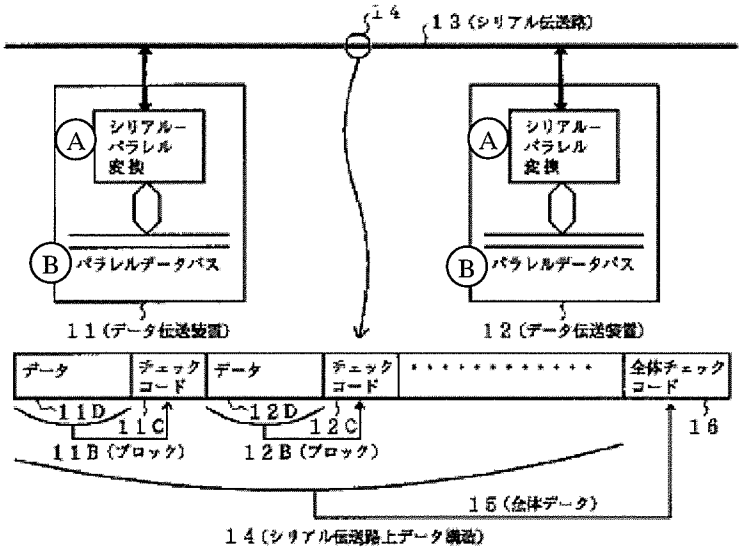
Abstract

Problem

To provide a data transmitting device that can improve the data variation detecting capability for serial data and can minimize data retransmission when data variation occurs.

Means to solve

In a data transmitting device equipped with at least one data transmitting means that exchanges serial data with other data transmitting devices, one transmitted data unit is divided into plural blocks of fixed length. An error checking code is adopted that can detect a data variation of 1 bit for each of said divided plural blocks, and a transmitted data unit is adopted that has the same error checking code for the entire one transmitted data unit. In this way, the data variation detecting capability can be improved during transmission, and abnormalities in the serial data exchanged by said transmitting means can be detected. Consequently, the data variation detecting capability can be improved during transmission.



Key:

A	Serial – parallel conversion
B	Parallel data bus
11	Data transmitting device
12	Data transmitting device
11B, 12B	Block
11C, 12C	Check code
11D, 12D	Data
13	Serial transmission line
14	Data structure on the serial transmission line
15	Overall data
16	Overall check code

Claims

1. A data transmitting device equipped with at least one data transmitting means that exchanges data with other data transmitting devices, characterized by the following facts: one transmitted data unit is divided into plural blocks of fixed length; an error checking code is adopted that can detect a data variation of 1 bit for each of said divided plural blocks, and a transmitted data unit is adopted that has a similar error checking code for the entire one transmitted data unit.

2. The data transmitting device described in Claim 1 characterized by the fact that data divided into a fixed length are arranged side by side in the longitudinal direction, and an error checking code that can detect a data variation of 1 bit is adopted with respect to the data string in the longitudinal direction.

3. The data transmitting device described in Claim 1 characterized by the fact that a data variation of 1 bit can be repaired for the data of plural blocks divided into a fixed length, and an ECC code that can detect a data variation of two bits is used.

4. The data transmitting device described in Claim 2 characterized by the following facts: one transmitted data unit is divided into plural blocks of fixed length; an ECC code is adopted for each of the divided plural blocks; also, the data divided into a fixed length are arranged side by side in the longitudinal direction; and an ECC code is also adopted for that data string in the longitudinal direction.

5. The data transmitting device described in any of Claims 1-4 characterized by the fact that only the divided block with an error is retransmitted without invalidating all of the data that have been transmitted if a data variation is detected that cannot be repaired.

6. The data transmitting device described in Claim 3 or 4 characterized by the fact that a check using the ECC code is performed only when the error checking code added to the entire transmitted data is abnormal.

7. The data transmitting device described in Claim 3 or 4 characterized by the following fact: if data variation can be repaired using the ECC code, the repaired data are used to calculate the error checking code for all of the data that will be retransmitted, and this is compared with the error checking code of the data that have been transmitted.

8. The data transmitting device described in Claim 3 characterized by the fact that if a repairable error of 1 bit is detected by the ECC code, the transmission speed is reduced stepwise.

9. The data transmitting device described in Claim 3 characterized by the fact that if a repairable error of 1 bit is not detected using the ECC code, the transmission speed is increased stepwise.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention pertains to a data transmitting device equipped with a data transmitting means that can exchange serial data with other data transmitting devices. In particular, the present invention pertains to a data transmitting device that can detect abnormalities in serial data.

[0002]

Prior art

Figure 10 shows serial data exchanged between conventional data transmitting devices. Data transmitting devices 101 and 102 are connected by serial transmission line 103. Serial data with a structure represented by 10A are exchanged between the two data transmitting devices. Serial data 10A are constituted with data part 10B and error checking code 10C.

[0003]

Problems to be solved by the invention

If the data part 10B of serial data 10A varies during transmission, said variation can usually be detected by error checking code 10C. However, depending on how the data variation has come about (for example, when a burst error occurs during use of CRC error checking code), error checking code 10C may become the same before and after data variation occurs. As a result, the data variation cannot be detected.

[0004]

The purpose of the present invention is to solve the aforementioned problem by providing a data transmitting device that can improve the data variation detecting capability for serial data and can minimize data retransmission when data variation occurs.

[0005]

Means for solving the problems

In order to realize the aforementioned purpose, Claim 1 of the present invention provides a data transmitting device equipped with at least one data transmitting means that exchanges data with other data transmitting devices, characterized by the following facts: one transmitted data unit is divided into plural blocks of fixed length; an error checking code is adopted that can detect a data variation of 1 bit for each of said divided plural blocks, and a transmitted data unit is adopted that has a similar error checking code for the entire one transmitted data unit.

According to the invention of Claim 1, the data variation detecting capability during transmission can be improved, and abnormalities in the serial data exchanged by said transmitting means can be detected.

[0006]

According to Claim 2 of the present invention, in the data transmitting device described in Claim 1, the data divided into a fixed length are arranged side by side in the longitudinal direction, and an error checking code that can detect data variation of 1 bit is used in the same way for the data string in the longitudinal direction.

[0007]

According to the invention of Claim 2, the serial data exchanged by the data transmitting device are divided into plural blocks of fixed length, and the data are arranged in the longitudinal direction. An error checking code that can detect a data variation of 1 bit is adopted for the data string in the longitudinal direction in the same way as in the lateral direction. In this way, the number of error checking codes is tripled including those added to the entire transmitted data unit, so that the data variation detecting capability during transmission can be improved.

[0008]

According to Claim 3 of the present invention, in the data transmitting device described in Claim 1, a data variation of 1 bit can be repaired for the data of plural blocks divided into a fixed length, and an ECC code that can detect a data variation of two bits is used.

[0009]

According to the invention of Claim 3, the data exchanged by the data transmitting device are divided into plural blocks of fixed length, and an ECC code is used for each of the divided plural blocks. In this way, the data variation detecting capability during transmission can be improved, and even a data variation of 1 bit can be repaired automatically.

[0010]

According to Claim 4 of the present invention, in the data transmitting device described in Claim 2, one transmitted data unit is divided into plural blocks of fixed length. An ECC code is adopted for each of the divided plural blocks. Also, the data divided into a fixed length are arranged side by side in the longitudinal direction, and an ECC code is also adopted for that data string in the longitudinal direction.

[0011]

According to the invention of Claim 4, an ECC code is adopted for the data string in the longitudinal direction in the same way as in the lateral direction. Consequently, even if a data variation of 2 bits or more occurs in the same block, it can be repaired automatically if the data variation in the longitudinal direction is kept to 1 bit.

[0012]

According to Claim 5 of the present invention, in the data transmitting device described in any of Claims 1-4, only the divided block with an error is retransmitted without invalidating all of the data that have been transmitted if a data variation is detected that cannot be repaired. According to the invention of Claim 5, the use efficiency of the transmission line can be increased, and the time needed for transmission/receiving can be reduced.

[0013]

According to the invention of Claim 6, in the data transmitting device described in Claim 3 or 4, confirmation by using the ECC code is performed only when the error checking code added to the entire transmitted data is abnormal. According to the invention of Claim 6, the processing load can be reduced when receiving the transmitted serial data, and the data variation repairing function can be maintained.

[0014]

According to Claim 7 of the present invention, in the data transmitting device described in Claim 3 or 4, if data variation can be repaired using the ECC code, the repaired data are used to calculate the error checking code for all of the data that will be retransmitted and this is compared with the error checking code of the data that have been transmitted. According to the invention of Claim 7, the validity of the data repair can be confirmed so that only correctly repaired data will be used.

[0015]

According to Claim 8 of the present invention, in the data transmitting device described in Claim 3, if a repairable error of 1 bit is detected by the ECC code, the transmission speed is reduced stepwise.

[0016]

According to the invention of Claim 8, when a repairable error of 1 bit is detected by using the ECC code, data variation that cannot be repaired can be prevented before it occurs by reducing the transmission speed stepwise.

[0017]

According to Claim 9 of the invention, in the data transmitting device described in Claim 3, if a repairable error of 1 bit is not detected using the ECC code, the transmission speed is increased stepwise.

[0018]

According to the invention of Claim 9, if no repairable 1-bit error is detected using the ECC code, transmission can be performed at the highest speed at which the transmission quality is maintained by increasing the transmission speed stepwise.

[0019]

Embodiment of the invention

In the following, an embodiment of the present invention will be explained based on figures. Figure 1 is a block diagram illustrating a data transmitting device in the first application example (corresponding to Claim 1) of the present invention.

[0020]

As shown in the figure, data transmitting device 11 is connected via serial transmission line 13 to data transmitting device 12 that has the same function. Serial data can be exchanged via said serial transmission line 13.

[0021]

The data transmitting device disclosed in this application example is constituted as described above. The data transmitted on serial transmission line 13 have data structure 14 on said serial transmission line. That is, said data structure 14 on the serial transmission line is composed of plural blocks represented as block 1B, block 12B, ... Block 11B is composed of data 11D and checking code 11C. Checking code 11C can be used to detect data variation of 1 bit in data 11D. Block 12B and other blocks have the same structure as block 11B.

[0022]

Entire data 15 is the aggregate of all of the blocks. Overall checking code 16 can be used to detect data variation of 1 bit in entire data 15. For example, if the checking code is just overall checking code 16, a variation of 2 or more bits occurring in entire data 15 cannot be detected. However, if data variation in each block is kept within 1 bit like said serial data transmission line data structure 14, 100% of data variation can be detected.

[0023]

Figure 2 is a block diagram illustrating the serial transmission line data structure in the second application example (corresponding to Claim 2) of the present invention. As shown in the figure, data structure 24 on the serial transmission line disclosed in this application example is composed of plural blocks 2A, 2B ... 2Y. Each block is composed of data (aa, ba, ...) and checking codes (ab, bb, ...) that can detect data variation of 1 bit as shown in Figure 1. The blocks are arranged in the longitudinal direction, and the checking codes in the longitudinal direction form block 2Z. Checking code 23 that can detect data variation of 1 bit in the entire data is added to blocks 2A-2Z.

[0024]

According to this application example, since the checking codes are arranged in a matrix form, if the data variation is kept within 1 bit in the data blocks in the longitudinal and lateral directions, 100% of data variations can be detected. Since data variation in serial data usually occurs in consecutive bits, data variation in these cases can also be detected effectively.

[0025]

Figure 3 is a block diagram illustrating the serial transmission line data structure in the third application example (corresponding to Claim 3) of the present invention. As shown in the figure, serial transmission line data structure 33 disclosed in this application example is composed of plural blocks 3A, 3B, ... 3Z. Each block has ECC code 31 that can repair data variation of 1 bit and can detect data variation of 2 bits. Also, checking code 32 that can detect data variation of 1 bit in the entire data is added to blocks 3A-3Z.

[0026]

According to this application example, by using the ECC code, the data can be repaired if the data variation in each data block is kept within 1 bit. Therefore, retransmission of data is not needed, and the transmission efficiency can be improved. Also, by using the ECC code, the data variations can be detected 100% if the data variation in each data block is kept within 2 bits.

[0027]

Figure 4 is a block diagram illustrating the serial transmission line data structure in the third application example (corresponding to Claim 4) of the present invention. As shown in the figure, serial transmission line data structure 44 disclosed in this application example is composed of plural blocks 4A, 4B, ... 4Y. Each block has ECC code 41 that can repair data variation of 1 bit and can detect data variation of 2 bits in the same way as shown in Figure 3. The blocks are arranged in the longitudinal direction, and the ECC codes 42 in the longitudinal direction form block 4Z. Also, checking code 43 that can detect data variation of 1 bit in the entire data is added to blocks 4A-4Z.

[0028]

According to this application example, when the ECC codes are arranged in a matrix form, if data variation in each data block in the longitudinal and lateral directions is kept within 1 bit, the data can be repaired 100%. Also, if the data variation in each data block in the longitudinal and lateral directions is kept within 2 bits, the data variations can be detected 100%. Since data variation in serial data usually occurs in consecutive bits, data repair or detection of data variation can be performed effectively in such cases.

[0029]

Figure 5 is the block diagram of the fifth application example (corresponding to Claim 5) of the present invention. In this application example, the figure shows the exchange of serial data between data transmitting devices 51 and 52 if data variation occurs. As shown in Figures 1-4, data transmitting device 51 divides one serial data [unit] into plural blocks. If there is data variation that cannot be repaired in 1 block during communication of serial data having respective checking code, a request for retransmission of the block concerned is sent from data transmitting device 52 to data transmitting device 51. Data transmitting device 51 only retransmits the block concerned to data transmitting device 52. Data transmitting device 52 combines the retransmitted block with all of the data that have already been transmitted to obtain the entire data without data variation. According to this application example, since only the block with data variation is retransmitted, the amounts of retransmission time and of retransmitted data can both be reduced.

[0030]

Figure 6 is the block diagram of the sixth application example (corresponding to Claim 6) of the present invention. The figure shows the processing in this application example when the

checking code is normal/abnormal. For the serial transmission that has been explained in Figures 3, 4, when data are received (step S1) only the overall checking code is examined (step S2) without examining the ECC code assigned to each block. If the overall checking code is normal, reception is considered to have terminated normally (step S6). If the overall checking code is abnormal, the ECC code of each block will be checked (step S3). If repair of the data is completed (step S4), reception is considered to have terminated normally (step S6). If the data cannot be repaired using the ECC code (step S4), data reception is considered to have terminated abnormally (step S5). According to this application example, since the entire processing can be carried out using software, no special hardware is needed. Data retransmission when data variation occurs can be reduced.

[0031]

Figure 7 is a flow diagram illustrating the processing in the seventh application example (corresponding to Claim 7). The figure shows the processing depending on whether there is data repair using the ECC code. For the serial transmission that is illustrated in Figure 3, when data are received (step S1), if data are repaired using the ECC code assigned to each block (step S2), the overall checking code is calculated for the data after the repair (step S3). The calculated value is then compared to the received checking code (step S4). If they are the same, it means that data repair has been completed, and data reception is normal (step S6). On the other hand, if they are different from each other, it means that data reception is abnormal (step S5).

[0032]

According to this application example, the checking code of the data after repair using the ECC code is calculated and is compared with the checking code used during data reception. In this way, the validity of the data repair can be confirmed so that the reliability of the transmitted data can be improved.

[0033]

Figure 8 is a flow diagram illustrating the processing in the eighth application example (corresponding to Claim 8). In this application example, the figure shows exchange of serial data between data transmitting device 81 and data transmitting device 82 for the data transmitting device shown in Figure 3. If repairable data variation is detected in the data sent from data transmitting device 81 to data transmitting device 82 at communication speed A, the information regarding the detection and the information for lowering the communication speed to A-1 are communicated to data transmitting device 82 from data transmitting device 81. After that, the communication speed is lowered to A-1 so that no data variation will occur.

[0034]

In many cases, the serial transmission error will be alleviated when the communication speed is lowered. In this application example, even if data variation occurs, the occurrence of unrepairable error can be avoided by lowering the transmission speed appropriately so that the data can be repaired.

[0035]

Figure 9 is the block diagram of the ninth application example (corresponding to Claim 9). In this application example, the figure shows the exchange of serial data between data transmitting devices 91 and 92 for the data transmitting device shown in Figure 3. If data can be received from data transmitting device 91 by data transmitting device 92 without problems at communication speed A, the information regarding reception of the data without problems and the information for increasing the communication speed to A+1 are communicated to data transmitting device 91 from data transmitting device 92. After that, the communication speed is increased to A+1. If the result is satisfactory at communication speed A+1, the communication speed will be increased to A+2 in the same way. The communication speed is then set one level lower than the final communication speed at which data variation occurs.

[0036]

According to this application example, since communication can be carried out at the highest speed that is free of data variation, the communication speed can be increased. Also, there is no need to generate a special test frame or invalid data while setting the communication speed.

[0037]

Effects of the invention

As explained above, the claims of the present invention have the following effects. According to the invention of Claim 1, the serial data exchanged by the data transmitting device are divided into plural blocks of fixed length. An error checking code is adopted that can detect data variation of 1 bit for each of said divided plural blocks, and a transmitted data unit is adopted that has the same error checking code for the entire one transmitted data unit. In this way, the data variation detecting capability during transmission can be improved.

[0038]

According to the invention of Claim 2, the data exchanged by the data transmitting device are divided into plural blocks of fixed length, and the data are arranged side by side in the longitudinal direction. An error checking code that can detect a data variation of 1 bit is used in the same way for the data string in the longitudinal direction. In this way, the number of error checking codes is tripled including those added to the entire transmitted data unit, so that the data variation detecting capability during transmission can be improved.

[0039]

According to the invention of Claim 3 of the present invention, the data exchanged by the data transmitting device are divided into plural blocks of fixed length, and an ECC code that can repair data variation of 1 bit and can detect data variation of two bits is used for each of the divided plural blocks. In this way, the data variation detecting capability during transmission can be improved, and data variations of 1 bit can even be repaired automatically.

[0040]

According to the invention of Claim 4, the data exchanged by the data transmitting device are divided into plural blocks of fixed length, and the data are arranged side by side in the longitudinal direction. An ECC code is adopted in the same way as that in the lateral direction to the data string in the longitudinal direction. Consequently, even if data variation of 2 bits or more occurs in the same block, it can be repaired automatically if the data variation in the longitudinal direction is kept to 1 bit.

[0041]

According to the invention of Claim 5, only the divided block with an error is retransmitted, without invalidating all of the data that have been transmitted, if a data variation is detected that cannot be repaired. Therefore, the use efficiency of the transmission line can be increased, and the time needed for transmission/receiving can be reduced.

[0042]

According to the invention of Claim 6, confirmation by using the ECC code is performed only when the error checking code added to the entire transmitted data is abnormal. In this way, the processing load can be reduced when receiving the transmitted serial data, and the data variation repair function can be maintained.

[0043]

According to the invention of Claim 7, if data variation can be repaired using the ECC code, the repaired data are used to calculate the error checking code for all of the data that will be retransmitted, and this is compared with the error checking code of the data that have been transmitted. In this way, the validity of the data repair can be confirmed so that only correctly repaired data will be used.

[0044]

According to the invention of Claim 8, if a repairable error of 1 bit is detected by the ECC code, the transmission speed is reduced stepwise. Therefore, data variation that cannot be repaired can be prevented before it occurs.

[0045]

According to the invention of Claim 9, if no repairable error of 1 bit is detected using the ECC code, the transmission speed is increased stepwise. Therefore, transmission can be performed at the highest speed that allows maintaining the transmission quality.

Brief description of the figures

Figure 1 is a block diagram using the data transmitting device in a first application example of the present invention.

Figure 2 is the block diagram of the serial transmission line data structure in a second application example of the present invention.

Figure 3 is the block diagram of the serial transmission line data structure in a third application example of the present invention.

Figure 4 is the block diagram of the serial transmission line data structure in a fourth application example of the present invention.

Figure 5 is a serial transmission line data communication procedure diagram in a fifth application example of the present invention.

Figure 6 is a serial transmission line data communication procedure diagram in a sixth application example of the present invention.

Figure 7 is a serial transmission line data communication procedure diagram in a seventh application example of the present invention.

Figure 8 is a serial transmission line data communication procedure diagram in an eighth application example of the present invention.

Figure 9 is a serial transmission line data communication procedure diagram in a ninth application example of the present invention.

Figure 10 is a block diagram using a conventional data transmitting device.

Explanation of symbols

10A	Serial data
10B	Data part
10C	Error checking code
101, 102	Data transmitting device
103	Serial transmission line
11, 12, 51, 52, 81, 82, 91, 92	Data transmitting device
13	Serial data line
3	Serial transmission line
14, 24, 33, 44	Structure of data on serial transmission line
2A, 2B, 2Y, 2Z, 3A, 3B, 3Z, 4A, 4B, 4Y, 4Z, 11B, 12B	Block
11D	Data
11C, 23, 32, 43	Checking code
15	Entire data
161	Overall checking code
31, 41, 42	ECC code

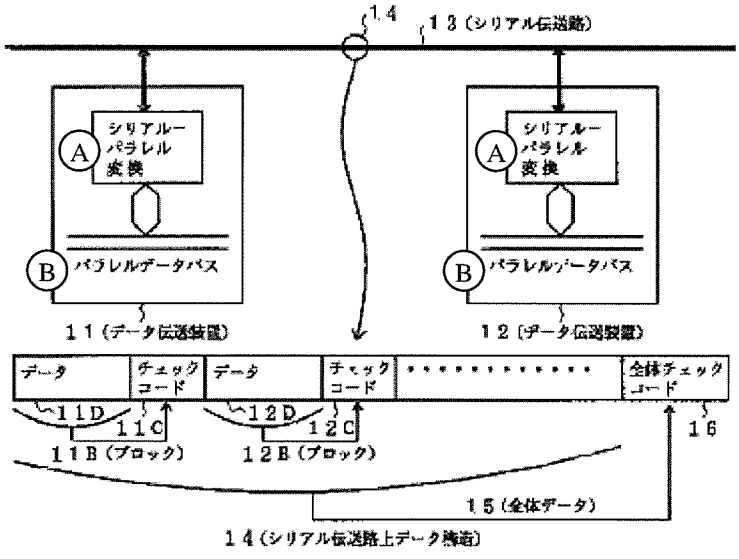


Figure 1

Key:

A	Serial – parallel conversion
B	Parallel data bus
11	Data transmitting device

12	Data transmitting device
11B, 12B	Block
11C, 12C	Check code
11D, 12D	Data
13	Serial transmission line
14	Data structure on the serial transmission line
15	Overall data
16	Overall check code

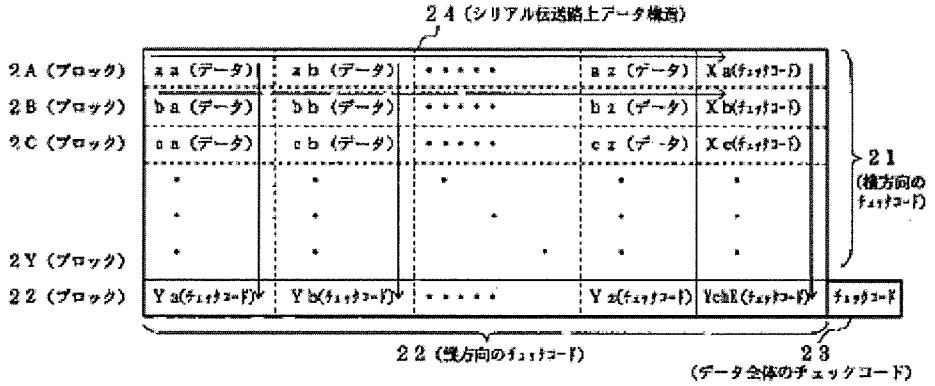


Figure 2

Key:	2A – 2Z	Block
	aa – cz	Data
	Xa – Xc	Checking code
	Ya – Ych	Checking code
	21	Checking code in lateral direction
	22	Checking code in longitudinal direction
	23	Checking code for the entire data
	24	Structure of data on serial transmission line

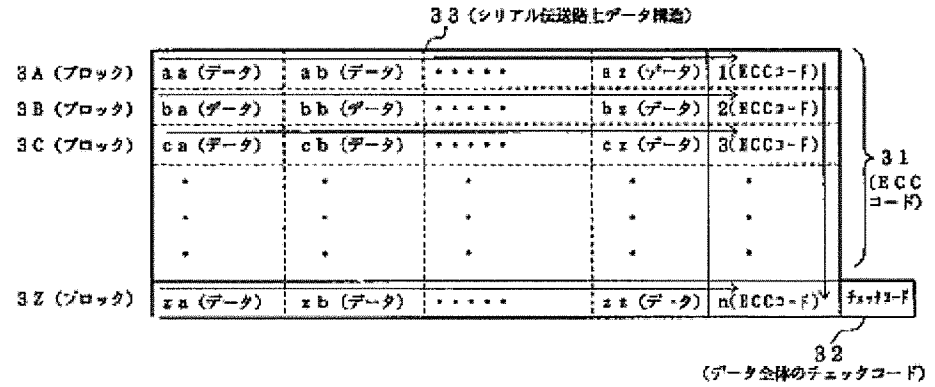


Figure 3

Key:		
	3A – 3Z	Block
	aa – zz	Data
	1 – n	ECC code
	31	ECC code
	32	Checking code for the entire data
	33	Structure of data on serial transmission line

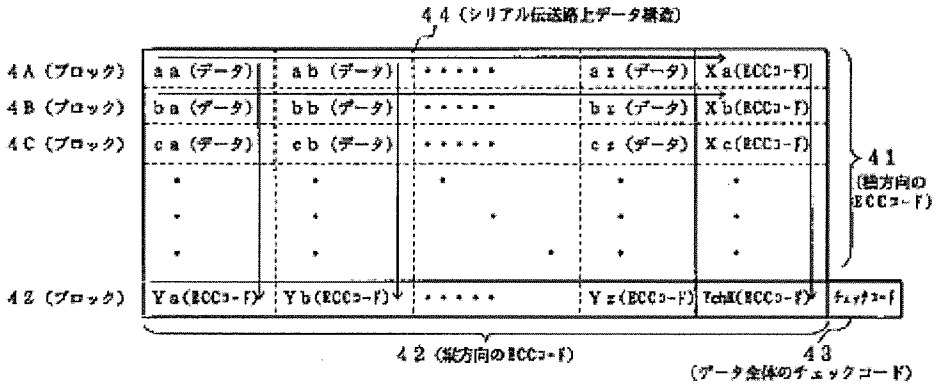


Figure 4

Key:		
	4A- 4Z	Block
	aa – cz	Data
	Xa – Xc	ECC code
	Ya – Ychk	ECC code
	41	EEC code in lateral direction
	42	ECC code in longitudinal direction
	43	Checking code for the entire data
	44	Structure of data on serial transmission line

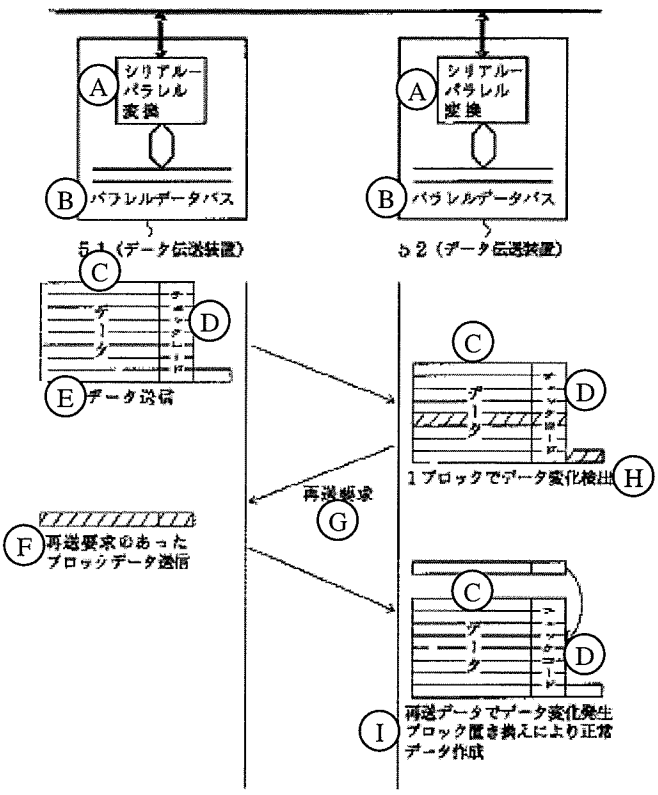


Figure 5

Key:
- A Serial – parallel conversion
- B Parallel data bus
- C Data
- D Checking code
- E Transmit data
- F Transmit data for which retransmission is required
- G Retransmission request
- H Detect data variation in one block
- I Form normal data by substituting the retransmitted data from the block with data variation
- 51, 52 Data transmitting device

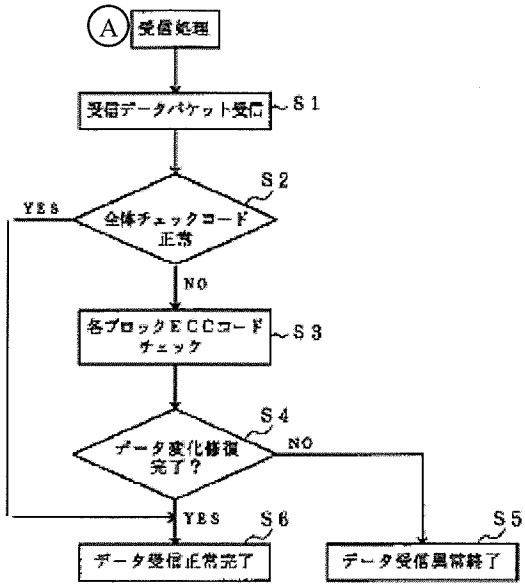


Figure 6

Key: A Receiving operation
S1 Receive data packets
S2 Is the overall checking code normal?
S3 Check the ECC code of each block
S4 Is repair of data variation finished?
S5 Data reception is terminated abnormally
S6 Data reception is terminated normally

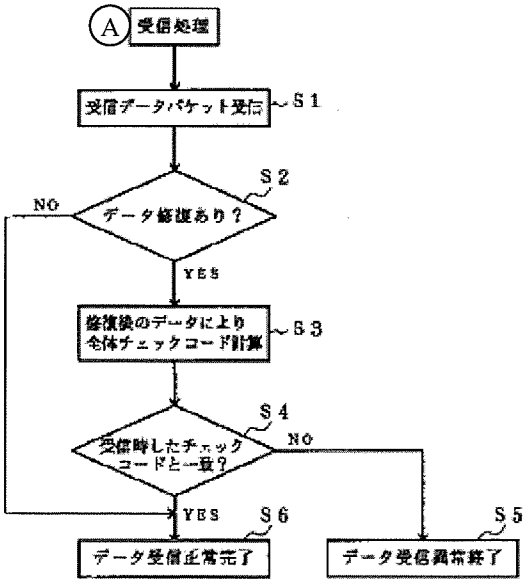


Figure 7

Key: A Receiving operation
S1 Receive data packets
S2 Is there data repair?
S3 Calculate the overall checking code by using the repaired data
S4 Is it the same as the checking code during reception?
S5 Data reception is terminated abnormally
S6 Data reception is terminated normally

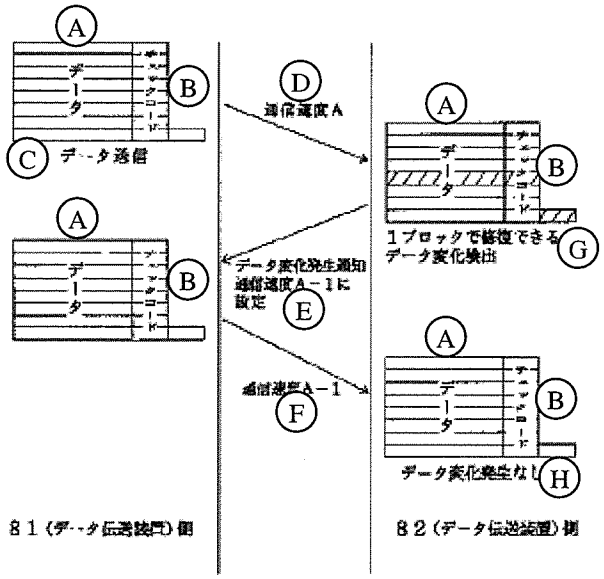


Figure 8

Key: A Data
B Checking code
C Transmit data
D Communication speed A
E Notification of occurrence of data variation
Set to communication speed A-1
F Communication speed A-1
G Detect repairable data variation in one block
H No data variation
Side of 81 (data transmitting device)
Side of 82 (data transmitting device)

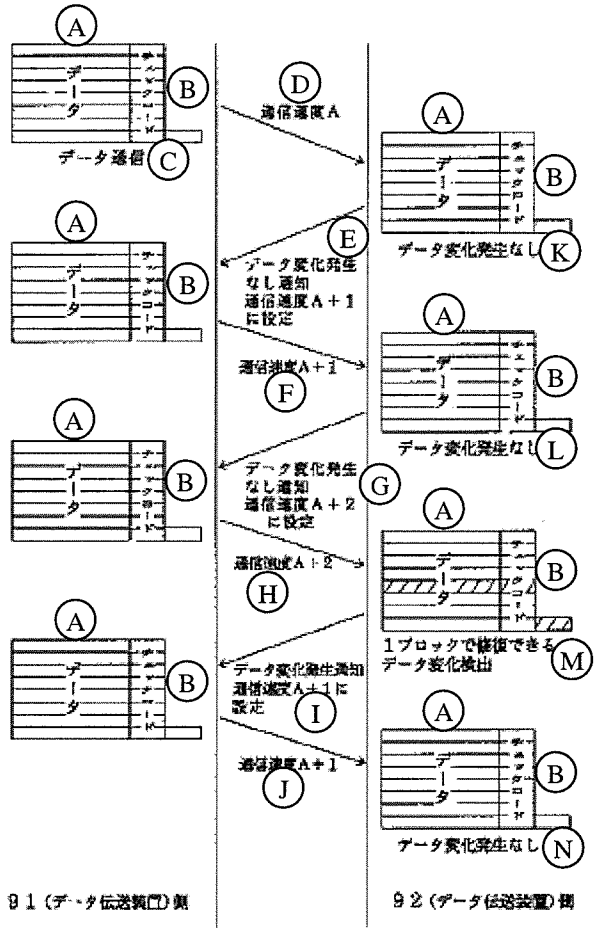


Figure 9

Key:
- A Data
- B Checking code
- C Transmit data
- D Communication speed A
- E Notification of no occurrence of data variation
  Set communication speed to A+1
- F Communication speed A+1
- G Notification of no occurrence of data variation
  Set communication speed to A+2
- H Communication speed A+2
- I Notification of occurrence of data variation
  Set communication speed to A+1
- J Communication speed A+1
- K No data variation
- L No data variation
- M Detect repairable data variation in 1 block
- N No data variation

Side of 91 (data transmitting device)
Side of 92 (data transmitting device)

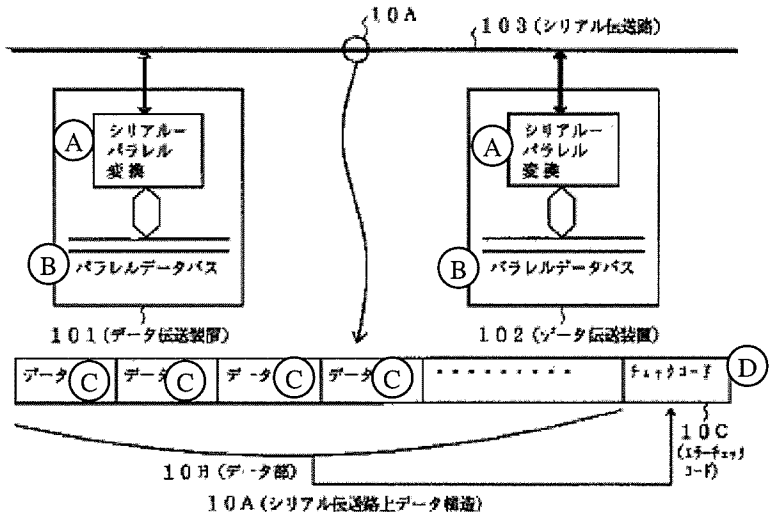


Figure 10

Key:		
	A	Serial – Parallel conversion
	B	Parallel data bus
	C	Data
	D	Checking code
	10A	Structure of data on serial transmission line
	10B	Data part
	10C	Checking code
	101, 102	Data transmitting device
	103	Serial transmission line